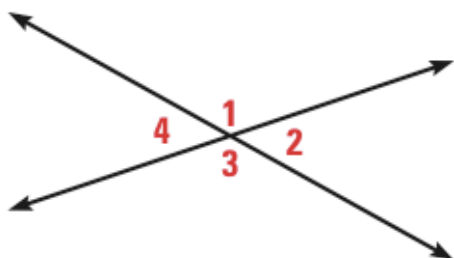
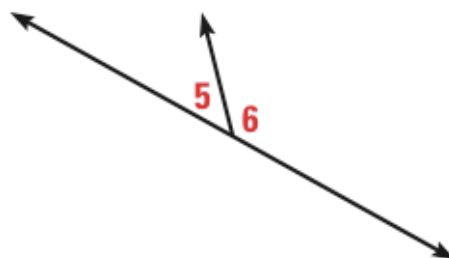


Two angles are **vertical angles** if their sides form two pairs of opposite rays. Two adjacent angles are a **linear pair** if their noncommon sides are opposite rays.



$\angle 1$ and $\angle 3$ are vertical angles.
 $\angle 2$ and $\angle 4$ are vertical angles.



$\angle 5$ and $\angle 6$ are a linear pair.

In this book, you can assume from a diagram that two adjacent angles form a linear pair if the noncommon sides appear to lie on the same line.

GOAL 2 COMPLEMENTARY AND SUPPLEMENTARY ANGLES

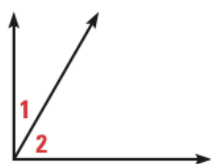
STUDENT HELP

Study Tip

In mathematics, the word *complement* is related to the phrase *to complete*. When you draw the complement of an angle, you are “completing” a right angle. (The word *compliment* is different. It means something said in praise.)

Two angles are **complementary angles** if the sum of their measures is 90° . Each angle is the **complement** of the other. Complementary angles can be adjacent or nonadjacent.

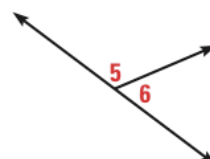
Two angles are **supplementary angles** if the sum of their measures is 180° . Each angle is the **supplement** of the other. Supplementary angles can be adjacent or nonadjacent.



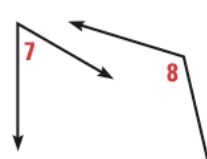
complementary
adjacent



complementary
nonadjacent



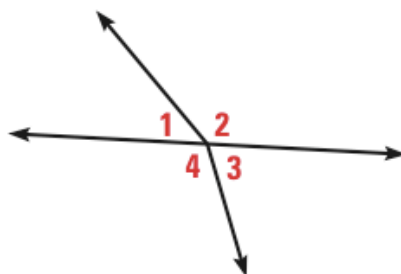
supplementary
adjacent



supplementary
nonadjacent

EXAMPLE 1 *Identifying Vertical Angles and Linear Pairs*

- a. Are $\angle 2$ and $\angle 3$ a linear pair?
- b. Are $\angle 3$ and $\angle 4$ a linear pair?
- c. Are $\angle 1$ and $\angle 3$ vertical angles?
- d. Are $\angle 2$ and $\angle 4$ vertical angles?



SOLUTION

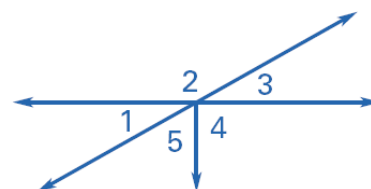
- a. No. The angles are adjacent but their noncommon sides are not opposite rays.
- b. Yes. The angles are adjacent and their noncommon sides are opposite rays.
- c. No. The sides of the angles do not form two pairs of opposite rays.
- d. No. The sides of the angles do not form two pairs of opposite rays.

1. Are $\angle 1$ & $\angle 2$ a linear pair?

2. Are $\angle 4$ & $\angle 5$ a linear pair?

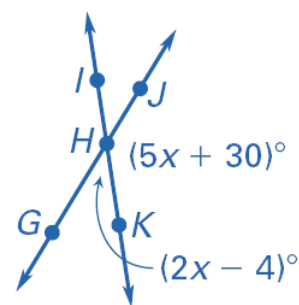
3. Are $\angle 5$ & $\angle 3$ vertical angles?

4. Are $\angle 1$ & $\angle 3$ vertical angles?



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(pp 44-46)

5. Guided Practice: Name one pair of vertical angles and one pair of angles that form a linear pair.



Examples



EXAMPLE 2 *Finding Angle Measures*

In the stair railing shown at the right, $\angle 6$ has a measure of 130° . Find the measures of the other three angles.

SOLUTION

$\angle 6$ and $\angle 7$ are a linear pair. So, the sum of their measures is 180° .

$$m\angle 6 + m\angle 7 = 180^\circ$$

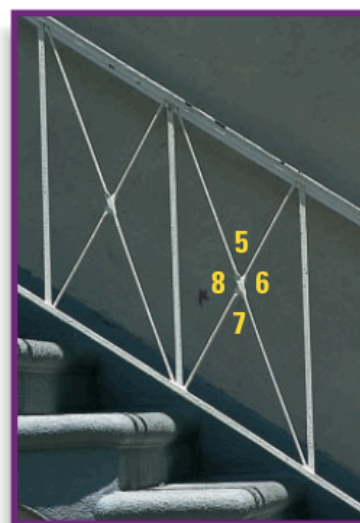
$$130^\circ + m\angle 7 = 180^\circ$$

$$m\angle 7 = 50^\circ$$

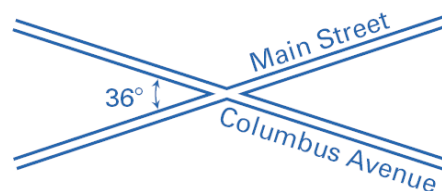
$\angle 6$ and $\angle 5$ are also a linear pair. So, it follows that $m\angle 5 = 50^\circ$.

$\angle 6$ and $\angle 8$ are vertical angles. So, they are congruent and have the same measure.

$$m\angle 8 = m\angle 6 = 130^\circ$$



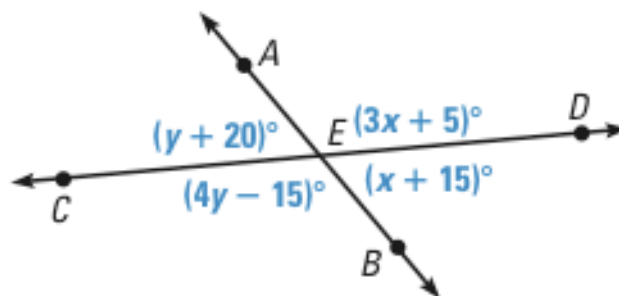
6. In one town, Main Street and Columbus Avenue intersect to form an angle of 36° . Find the measures of the other three angles.



EXAMPLE 3 *Finding Angle Measures*

Solve for x and y .

Then find the angle measures.



SOLUTION

Use the fact that the sum of the measures of angles that form a linear pair is 180° .

$$m\angle AED + m\angle DEB = 180^\circ$$

$$m\angle AEC + m\angle CEB = 180^\circ$$

$$(3x + 5)^\circ + (x + 15)^\circ = 180^\circ$$

$$(y + 20)^\circ + (4y - 15)^\circ = 180^\circ$$

$$4x + 20 = 180$$

$$5y + 5 = 180$$

$$4x = 160$$

$$5y = 175$$

$$x = 40$$

$$y = 35$$

Use substitution to find the angle measures.

$$m\angle AED = (3x + 5)^\circ = (3 \cdot 40 + 5)^\circ = 125^\circ$$

$$m\angle DEB = (x + 15)^\circ = (40 + 15)^\circ = 55^\circ$$

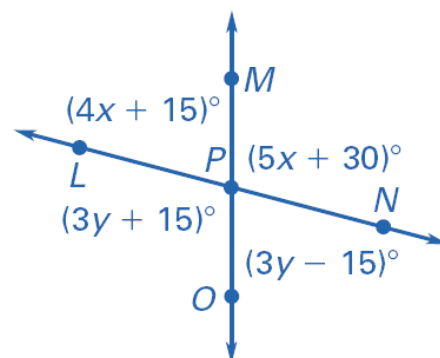
$$m\angle AEC = (y + 20)^\circ = (35 + 20)^\circ = 55^\circ$$

$$m\angle CEB = (4y - 15)^\circ = (4 \cdot 35 - 15)^\circ = 125^\circ$$

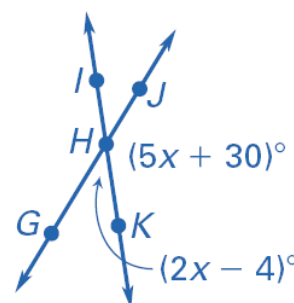
► So, the angle measures are 125° , 55° , 55° , and 125° . Because the vertical angles are congruent, the result is reasonable.

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7. Solve for x and y . Then find the angle measures.



8. What is the measure of $\angle GHI$?



EXAMPLE 4 *Identifying Angles*

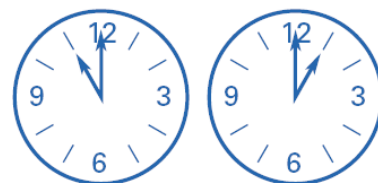
State whether the two angles are complementary, supplementary, or neither.

SOLUTION

The angle showing 4:00 has a measure of 120° and the angle showing 10:00 has a measure of 60° . Because the sum of these two measures is 180° , the angles are supplementary.



9. State whether the two angles are complementary, supplementary, or neither.



EXAMPLE 5 *Finding Measures of Complements and Supplements*

- a. Given that $\angle A$ is a complement of $\angle C$ and $m\angle A = 47^\circ$, find $m\angle C$.
b. Given that $\angle P$ is a supplement of $\angle R$ and $m\angle R = 36^\circ$, find $m\angle P$.

SOLUTION

- a. $m\angle C = 90^\circ - m\angle A = 90^\circ - 47^\circ = 43^\circ$
b. $m\angle P = 180^\circ - m\angle R = 180^\circ - 36^\circ = 144^\circ$

10. Given that $\angle G$ is a supplement of $\angle H$ and $m\angle G = 82^\circ$, find $m\angle H$.

11. Given that $\angle U$ is a complement of $\angle V$, and $m\angle U = 73^\circ$, find $m\angle V$.

EXAMPLE 6 *Finding the Measure of a Complement*

$\angle W$ and $\angle Z$ are complementary. The measure of $\angle Z$ is five times the measure of $\angle W$. Find $m\angle W$.

SOLUTION

Because the angles are complementary, $m\angle W + m\angle Z = 90^\circ$.
But $m\angle Z = 5(m\angle W)$, so $m\angle W + 5(m\angle W) = 90^\circ$. Because $6(m\angle W) = 90^\circ$, you know that $m\angle W = 15^\circ$.

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12. $\angle T$ & $\angle S$ are supplementary. The measure of $\angle T$ is half the measure of $\angle S$. Find $m\angle S$.

13. $\angle D$ & $\angle E$ are complements and $\angle D$ & $\angle F$ are supplements. If $m\angle E$ is four times $m\angle D$, find the measure of each of the three angles.

14. Explain the difference between complementary angles and supplementary angles.